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PRODUCTION OF GRAPE-HYACINTH BULBS

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GENERAL CHARACTERISTICS OF GRAPE HYACINTHS

The grape hyacinth (*Muscari* sp.), a group of the lily family, constitutes quite a distinct genus, separated from the common hyacinth mainly by the constriction of the mouth of the bell-shaped flower into a vase or urn. The plants may be looked upon as graceful small-flowered hyacinths.

The group in general is one of easy culture, no more difficult than the common hyacinth, is adapted to a much greater variety of conditions and treatments, and is capable of being produced under a much greater diversity of climatic and soil conditions.

The bulbs have always been cheap. In pre-war days the wholesale prices in the Netherlands were but $5 to $7 per thousand. Since that time they have not been available on our markets except temporarily. None was on sale at any price in commercial quantities from 1917 to 1923; not that there have not been a great many bulbs in the country, and a few commercial stocks are being developed, but there are not enough in the possession of any one individual to constitute a commercial supply.

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The plants are natives of the Mediterranean region of Europe, Asia, Africa, and eastward. They are early spring-flowering bulbs, blossoming from March to May. The prevailing colors are blue and shades of purple, particularly attractive in their season.

SOURCES OF SUPPLY

In some sections, particularly in the South, some of the older varieties of grape hyacinths have become naturalized under conditions that appear to assure clean, healthy stock, and these may become valuable as sources of propagating material. Forms of *Muscari botryoides* and a dark-colored very old variety are commonly seen scattered as weeds in cultivated fields and sometimes found naturalized in matted clumps in old gardens. These varieties are likely to be inferior to those now offered for sale. Owing to their prolific habits, a few thousand bulbs from such sources would produce commercial quantities very rapidly. For any of the named varieties in commercial quantities at the present time the prospective grower will be dependent upon imported stocks.

USES OF THE PLANTS

In general these species of grape hyacinths have been looked upon in this country as garden decorations and not as florist stocks. They have been used in herbaceous borders, edgings, and other permanent and semipermanent locations and are well adapted to naturalizing in grassy areas, in the edges of woodlands, borders of shrubbery, and similar situations. A few growers, particularly on the Pacific coast, are finding ready sale for the flowers, which when supplied with some added green or in combinations are decidedly decorative.

The main difficulty with the group for use as cut flowers is the shortness of stems. When, however, the plants are grown under conditions of good fertility, good culture, slight shade, and proper degree of crowding 10 to 12 inches of stem is easily possible, in such species as *Muscari conicum* especially. When grown in this way they are useful not only in simple bouquets with greens from some other source but also in wreaths and compound pieces generally. The yield is well-nigh phenomenal, so that the erection of a temporary shade to lengthen the stem is not a serious matter. There is illustrated in Plate I, Figure 1, an average of 100 flower spikes to the 3-foot row with rows 6 inches apart. A temporary shade here would be practicable.

VARIETIES AND THEIR COMMERCIAL APPLICATION

The literature contains upwards of 40 names applied to species and varieties of this genus of plants. Modern Dutch lists vary widely in the diversity of material which they offer. The most complete catalogues contain about 15 species and varieties, while the dealers who do not specialize in collections but offer those varieties most in demand list only about six. A half dozen varieties will fill ordinary requirements in the group. The others can well

be eliminated on the basis of too close similarity, lack of suitable vigor, or some other shortcoming, except for connoisseurs and those demanding completeness of collections rather than the most decorative and best growers.

The group is badly in need of botanical revision. Until this is accomplished there must be uncertainty regarding the names of the varieties. From a horticultural viewpoint this is not important, because the most desirable varieties are well recognized.

Were the writer obliged to make a choice of one variety of grape hyacinth there would be no hesitancy in selecting *Muscari conicum* (Pl. I, figs. 1 and 2) because of its beauty and extremely satisfactory reproduction, perfect from bulblets and fairly good from seed. It is fully realized that the trade generally handles Heavenly Blue rather than Conicum, the objections to which are sometimes made that it is too dark in color, that the florets in the spike do not all open at one time, and that the lower florets are fading by the time the upper ones are open. Under glass the variety is much lighter in color than out of doors. Half of the florets are open and in good condition at one time, the unopened ones are the same color, and the opened ones are not unattractive after a measure of fading, so that the attractive life of the flower spike is prolonged by these very characteristics. This variety is much less widely known than Heavenly Blue.

To those who delight in monstrosities the feathered hyacinth *Muscari comosum* and its variety *plumosum* will appeal, but it will never be used in such quantities as the group represented by *M. conicum*, being grown in dozens instead of thousands. In a list of the best varieties its mention is justified because it is decidedly different in many ways from other members of the genus. It is really in a class by itself.

The most widely used and best-known variety is without doubt Heavenly Blue, and public estimation of the grape hyacinths is by this standard. It must be admitted, however, that the difference between Heavenly Blue and Conicum is mainly one of vigor and intensification of size and color. The two are closely related, and by the casual observer the one would commonly be accepted as an intensified form of the other.

Besides several blue varieties the species *Muscari botryoides* has a white form (*M. b. alba*) and a light flesh-pink form (*M. b. carnea*), both of which have their place in ornamental borders but mainly in collections. These have proved comparatively weak varieties in these investigations, lacking the constitution and reproductive power of the best blue forms.

Muscari azurea is a blue, unique not only in this genus but in the whole floral kingdom. It invariably makes a decided appeal and has the advantage of not thickening up and becoming crowded so quickly in permanent plantings as the forms of *M. botryoides*. There are said to be many forms of this in nature, and these were once available, but now only one or two are offered in the trade.

Muscari monstrosum has some very interesting characteristics. It is a late variety, of a peculiar red-blue color and very odd inflorescence, which extends as the florets open. It is a species for the border.

DETRACTING CHARACTERISTICS

Without doubt the best horticultural varieties in the genus are included in the species *Muscari botryoides*. All the varieties of this species, however, have one characteristic which somewhat detracts from their value in herbaceous borders when compared with other early-flowering bulbous plants. This is their long vegetative period. The leaves appear above ground in late August or early September and continue in vegetative condition until the following June, long after the plants have blossomed. On this account this group is not adapted for planting in lawns, and if put in herbaceous borders it must have its tops left undisturbed when cleaning-up time comes for most plants in the fall. On Puget Sound *M. conicum* is practically evergreen.

The following varieties experimented with begin top growth in late summer and autumn and go through the winter in vegetative condition. All except *Muscari azurea* and its variety *amphibola* are very closely related and possibly may belong under *M. botryoides*, although several are listed as species in commerce: *Muscari azurea*, *M. a. amphibola*, *M. botryoides*, *M. b.* Heavenly Blue, *M. b. coerulea*, *M. b. conicum*, *M. b. alba*, *M. b. carnea*, *M. argei*, *M. elegans*, *M. neglectus*, *M. polyanthus*, *M. racemosus*, *M. szovitzianum*. The following remain below ground until spring: *Muscari monstrosum*, *M. paradoxum*, *M. comosum plumosum*, *M. latifolium*, *M. moschatus*, *M. m. major*.

WHO SHOULD GROW THE STOCKS

The production of grape-hyacinth bulbs is a line suited to the small rather than the large grower. These bulbs are not adapted for handling in large masses; indeed, disaster is very likely to follow an attempt to so handle them. The best producer will be one who has a small acreage intensively cultivated and will be content with a production of 100,000 or 200,000 bulbs well grown and perfectly "cured" before being put on the market. A crop of 100,000 bulbs can be produced biennially on about one-fifth of an acre, and it is not unlikely that this is all one grower should attempt, at least until he has thoroughly familiarized himself with the crop and its peculiarities.

The writer is fully aware that these views may be questioned by some who have found a few Muscari bulbs in beds and borders of such easy culture. But in spite of the ease of culture it is desired to repeat that to succeed one must first get clean stock and see that it is so maintained, for neglect of the stocks on the shelves for five or six days may mean irreparable losses. Indeed, the freshly dug bulbs may begin to slough their coats in 36 hours if left in lug boxes.

SOILS

The grape-hyacinth plants are very adaptable to soil conditions. Any good loam is satisfactory and if the drainage is properly taken care of will produce good crops. But while this is true, it is imperative that a friable loam be had for any considerable commercial production. Undoubtedly a sandy loam is best, all things considered. Here the cost of fertility will be higher, but the labor bill will be

FIG. 1.—BEDS OF MUSCARI CONICUM THE SECOND SEASON FROM BULBLETS

The yield of the three beds, 3 feet wide and with a total length of 94½ feet, planted with stock under 4 centimeters, was 13,000 merchantable bulbs

FIG. 2.—MUSCARI CONICUM GROWN FROM BULBS PRODUCED IN THE BEDS SHOWN IN FIGURE 1

These were grown under glass at the Arlington Experiment Farm, Va.

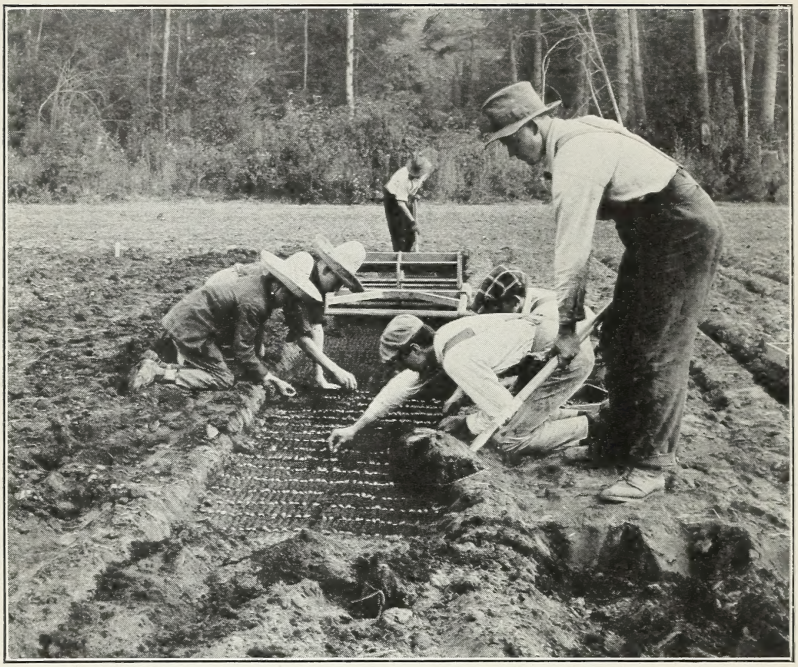

FIG. 1.—PLANTING BULBS WITH A CREW OF FOUR BOYS AND TWO MEN

FIG. 2.—DIGGING BULBS

Note that there are no surface indications of the location of the bulbs

correspondingly lower. Above all things this crop should not be attempted commercially on a heavy clay soil or one that bakes; not that the plants may not grow fairly well even there, but there will be too much difficulty in handling such a soil, and the reduced number of days in the year when it can be worked will lessen labor efficiency too much, especially in such a region as the Pacific Northwest, where efficiency is naturally low on account of the copious rainfall.

PLANTING AND CULTIVATION

Like many other bulbs, grape hyacinths are planted thickly and preferably in beds, their width varying with circumstances. A very convenient planting is the conventional bed 3 feet wide with rows 6 inches apart across it (Pl. II, fig. 1). The bulbs should be set 3 to 4 inches deep. With most of the Muscari the bulblets are strewn along the rows across the bed, occupying a space when planted possibly slightly less than 1 inch in width. At the end of two years the ribbon or row of bulbs will be matted and may be 2 inches or more wide, so that there will be 4 inches or less between the bulbs in contiguous rows, leaving just about room enough to dig nicely.

In setting the bulbs the smaller size can be strewn along the row about 3 to the inch, while the larger size may be set up about 14 to 21 to the 3-foot row. It is not believed that there is any advantage in setting up bulbs under 6 centimeters (about 2⅖ inches) in circumference.

Cultivation must be given during the dormant period and should be very thorough, to kill all weeds and put the surface in good tilth. In the case of the varieties which vegetate in late summer, this must be in July and August, but the others can be cultivated with a wheel hoe or other tools during the entire autumn. At other seasons the weeds must be removed by hand.

When digging takes place at the end of two years the ground is dug only about 4 inches deep if the planting be permanent, but if on another site the tillage can be made thorough, of course.

For best results the planting should be done as early as possible, because the leading varieties begin to show above ground in late August. The stocks, on the other hand, are wonderfully adaptable and may be held under good storage conditions up to December or even later.

Little cultivation is possible in such a planting, and indeed little is necessary under the conditions illustrated in Plate I, Figure 1. The few weeds that gain a foothold in the beds are pulled out by hand and the wheel hoe is run in the paths. As soon as the tops die down the whole surface is cleaned with hoe, wheel hoe, or scuffle hoe.

DIGGING OR HARVESTING

The digging of the bulbs does not differ from that of Dutch bulbs generally. If planted in 3-foot beds with the rows running across the bed the bulbs can be taken out with a short-handled small spade, the digger working on his knees on the dug-over space, as illustrated in Plate II, Figure 2. If the bulbs are grown on a sandy loam and the digging is done one year after planting, it can be accomplished with a flat-bladed garden trowel.

In cases where the crop is rotated to a new situation at each digging and the soil is friable enough, it will be found decidedly advantageous to screen out the bulbs, to insure a thorough and clean job. For this work it is desirable to construct a "shaker." This may be a rectangular box 6 feet long, 28 inches wide, and 8 inches deep with a one-fourth-inch mesh wire bottom. The wire bottom should terminate 1 foot from one end, and a movable partition should be fitted just ahead of the opening thus made. Over the opening is fitted a sack from which the bottom has been cut. This box is mounted in a stout frame on wires or pivots, so that it can swing through a small arc. It is operated by a man at each end. The box is "jerked" in such a way as to slide the contents from one end to the other, to remove the soil. When this is done, five or six more "jerks" will deliver the bulbs into the lug box beyond the removed partition.[1]

The bulbs of grape hyacinths when dug in the ordinary way, one row at a time, as illustrated in Plate II, Figure 2, have necessarily a great deal of soil attached to them, for they come out in clumps literally with masses of bulblets. The loose soil consequently can not be shaken off by hand before the bulbs are placed in the containers used in digging. It is customary, therefore, if the big shaker mentioned above is not employed, to provide digging boxes, usually referred to as screens, to receive the freshly dug bulbs. These screens may be 14 by 21 inches and 4 inches deep, having a one-fourth-inch mesh wire bottom. They should be constructed of light wood, and the ends should be double, with a handhold cut in the outer board. When the screen is half filled it is shaken lightly to remove the loose soil, after which the bulbs are transferred to the lug boxes or baskets for transportation to the storage house.

IMPORTANCE OF PROPER DRYING OF BULBS IN STORAGE

In no other group, except possibly the squills, is greater watchfulness necessary than in this one when the bulbs are on the shelves. The crux of the whole matter is to place the bulbs in thin layers under airy conditions to dry rapidly and thoroughly while in storage before being packed for shipment or stored for planting again.

After the bulbs have dried out well the light must be subdued; otherwise they turn green. In regions of higher summer temperatures and under longer storage periods protection from desiccation is necessary, for it is possible to wilt the bulbs too much. In the region of Washington, D. C., the bulbs keep well after being thoroughly dried in thin layers in dry cellars or half basements. The grower should realize that there is more danger from underdrying or slow drying than from overdrying or rapid drying. A little wilting is much less injurious than underdrying. The aim should be to dry the freshly dug bulbs quite rapidly for the first week or two and then reduce the ventilation so that the stocks at the close of the storage period will be but slightly wilted.

[1] A complete description and an illustration of this machine will be found in U. S. Dept. Agr. Bul. 1082, The Production of Tulip Bulbs. (See pp. 28 and 29; also Pl. IX, fig. 2.)

PACKING FOR SHIPMENT

The same cautions apply to packing for shipment as to drying in storage. The pack should be as well aerated as possible to prevent heating or an accumulation of moisture.

Foreign growers pack in grain chaff, but it is not believed that this sort of packing is necessary for transporting bulbs between points in this country unless the package is very large. In 1921 the Department of Agriculture shipped varieties of *Muscari conicum* and *M. comosum* in quantities of 100,000 in large perforated sacks holding 300 large bulbs, using ordinary tulip crates. They carried satisfactorily in a box car which was four weeks in transit across the continent.

In the leading commercial varieties the grower can protect his pack a great deal by his method of cleaning. If the planting is hoed off before digging there remain attached to the bulbs about 2 inches of stem and leaf bases. It has been the practice of the Department of Agriculture to leave these old stem and leaf bases attached when cleaning. This aerates the pack very decidedly and does not necessarily detract much from the appearance of the bulbs.

A POSSIBLE ADVANTAGEOUS METHOD OF GROWING

One of the difficulties in growing grape hyacinths and some other genera of the minor bulb lists is the weedy tendency of many of the varieties. It is not possible to get them all out in digging, nor does subsequent tillage kill them. Even if plowed under when in full vegetative vigor the bulbs seldom die but will appear the next season when left within 6 or 8 inches of the surface.

Since the yields can be made so large and the areas required are so small, it is suggested that the plan of a permanent planting like that adopted by some foreign growers may have decided advantages. In this method of handling, the bulbs are grown on the same ground continuously, the fertility being made up by liberal top-dressings of manure during the dormant season. The bulbs may be harvested annually or biennially, but when digging is done the merchantable bulbs are separated in the field and the bulblets immediately put back in the ground in rows the same as before. If the soil is naturally friable and fertility is maintained this plan for the production of these and other miscellaneous stocks inclined to be weedy seems to work satisfactorily.

Another advantage of this method is that it enables the grower to dig just what he needs in any particular season. If sales do not demand all the stock it can be left in the ground to grow. Within certain limits it will improve in quantity for several years at least, the bulbs often piling up on each other when the plantings become old.

The different species of the group will, of course, need different treatments. They are not all adapted to handling on the permanent-planting plan. The method is suited to those forms which are propagated vegetatively, like the varieties of *Muscari botryoides*, for they are the weedy ones. Forms reproduced from seed, like *M. azurea*, are not weedy and are more adapted to a treatment wherein

the seedlings are left in the seed bed two years and then moved to entirely new soil for another year to mature. The feathered hyacinth can be safely grown precisely like a daffodil, the smaller half of the propagation maturing in two years and giving in turn sufficient "splits" to continue the planting.

PREPARATION AND SIZING OF STOCKS

When the bulbs have thoroughly dried on the shelves they must be worked over by hand to remove the bulblets from the mother or merchantable bulbs. The best procedure at this time is to work on the trays or to dump the trays on a table, from which the bulbs are taken up. The propagation is rubbed off and allowed to fall back on the table, and the large bulbs are placed in containers by hand, thereby separating the bulbs into two lots. The point at which this separation is to take place may be 4, 5, or 6 centimeters (1⅗, 2, or 2⅖ inches), depending on what character of bulb it is desired to market and to what extent the planting is to be increased or diminished. If more than one size of bulb is sold, further sizing of the merchantable stock is necessary. This will have to be accomplished by hand, or if cleaned thoroughly of roots, leaf bases, and stem bases it can be done mechanically by the use of the conventional nesting sieves.[2]

After the first separation the bulblets on the table are shoveled into containers, and it is necessary to put them through a grain fanning mill or other "blower" to do a little more cleaning. The bulbs from the hopper of this machine are allowed to alight on a wire sieve of about one-fourth-inch mesh as they fall through the draft. This removes loose soil and small heavy particles which are not blown out.

Grape-hyacinth bulbs do not adapt themselves well to close sizing unless they are cleaned to a point that is burdensome. Fortunately, close sizing is not considered necessary; indeed, the hand separation described above will be sufficient in common practice, the smaller size being planted and the larger one sold.

PLANTING STOCKS

The character of the planting stock of grape hyacinths will depend upon the purpose and viewpoint of the grower and the demands of the market. Should the time come when these bulbs are used in large numbers for growing under glass, as is now common in foreign countries, those of large size will be in demand, but if for outside use bulbs of 5 to 7 centimeters (2 to 2⅘ inches) in circumference may be most desirable, all things considered.

When moderate-sized bulbs, 5 to 9 centimeters (2 to 3⅗ inches), are wanted after two years of undisturbed growth, the planting stock will consist of all the propagation under about 5 centimeters. When larger bulbs are desired, those up to 9 or 10 centimeters (3⅗ or 4 inches) in circumference will have to be used as planting stock.

[2] These sieves are described in detail in U. S. Dept. Agr. Bul. 1082, The Production of Tulip Bulbs. Substitutes can be made of nesting sieve hoops or boxes the bottoms of which are of suitable sizes of wire mesh. However, injury to the bulbs is much more likely to occur from wire than from perforated rawhide or laminated wood.

MERCHANTABLE STOCKS

Bulbs of the leading varieties of Muscari, such as Conicum, Heavenly Blue, and Coerulea, especially imported ones, are mostly small, being only 5 to 6 centimeters. Such stocks under good cultural conditions can be produced in one year from bulblets 3 to 4 centimeters in circumference. The 5-centimeter bulbs will always flower, usually with a single spike. In two years without transplanting they may reach 7 to 9 centimeters, and a third year if reset, set up, and spaced bulbs of *Muscari conicum* will reach 10 to 12 centimeters and throw three to five flower stems.

Manifestly the bulbs should be sold and bought according to size for definite purposes. The smaller bulbs (5 to 7 centimeters) are well adapted to outdoor use, but the larger ones are more suitable for growing in pots. Small bulbs should be employed for naturalizing.

In the feathered hyacinth the 9-centimeter bulb indicates normal maturity. The group reproducing from seed only may be represented by *Muscari azurea*, which should become 4 to 5 centimeters in size the second year and flower full the third. A full-sized bulb of this variety is from 6 to 7 centimeters in circumference. Bulbs 2 and 3 years old, well grown from seed are the salable ones.

FIG. 1.—*Muscari plumosum*, showing that the reproduction in this variety is similar to that of a daffodil

PROPAGATION

There are no difficulties attendant upon the increase of stock in this group when one is familiar with the characteristics of the varieties. The methods of reproduction vary with the varieties, and three distinct procedures are employed in the reproduction of the different members of the genus.

In the feathered hyacinth (*Muscari comosum* and its variety *plumosum*) the bulb splits naturally, very much like that of the daffodil (fig. 1). The bulbs may be broken apart at the base and grown exactly like Emperor or Empress daffodils. These varieties produce no seeds and are entirely dependent for their increase on the splitting of the bulbs.

On the contrary, the *Muscari botryoides* group reproduces by producing small globular bulblets, sessile or on short stocks, at the base of the mother bulb, very similar to a gladiolus corm (fig. 2). These bulblets, which may be 6 to 20 or more in number, are 2 to 3 centimeters in circumference. They constitute the planting stock by which the variety is increased.

The third method of reproduction is by seed. This method is applicable to all species except such as *Muscari comosum*, which is sterile. But in the case of *M. azurea* there is little or no reproduction of a vegetative character, and the only practicable way to increase stock is by seed (fig. 3).

GROWING FROM SEED

The reproduction of these plants from seed is easily accomplished. Seed production, however, will seldom be resorted to in a species which reproduces vegetatively except in case the grower's stock becomes contaminated.

Seeding should be done preferably in autumn or early spring. Any time from August 1 to November 1 gives good results on Puget Sound. Germination takes place in the spring even from August planting. In these experiments it was found most advantageous to put the seed in beds, because of the larger quantity which can be grown on a given area. Only handwork is applicable in handling seed and seedlings anyway. It is desirable to put the seed in thick, and this is accomplished by using rows across the

FIG. 2.—*Muscari conicum* bulb and bulblets grown in two years, from bulblets like the largest shown

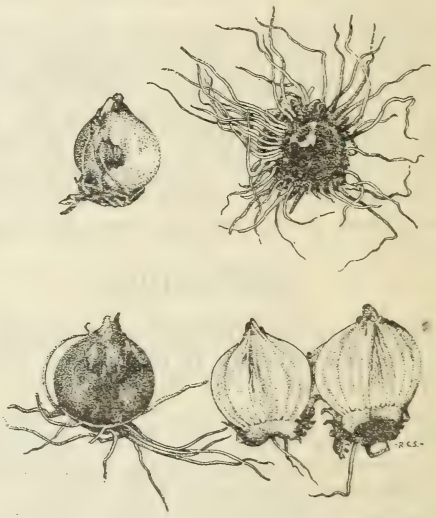

FIG. 3.—*Muscari azurea* bulbs about 8 years old beginning to show deterioration and no reproduction. Upper right, the base of a bulb which is very large, showing age. Lower right, a bulb split open. The other bulbs are ordinary normal specimens

bed but 3 inches apart. About 100 to 150 seeds covered 1 to 1¼ inches deep are drilled in the row. On Puget Sound all seeding is done under open field conditions, but the preparation of the bed is very thorough. Care should be exercised not to walk on a seeded bed thus planted until the soil has been well settled by rains. If this precaution is not taken the seed stepped on is certain to be pushed down so far that it can not get through the soil when it germinates in the spring.

In such a planting particular care should be taken to keep down all weeds until winter sets in, because the plants are small the first year, requiring hand weeding entirely in the spring after the seedlings are up, as is always the case with seedlings in frames. The burden of this weeding, although great for the area covered, is not severe when the quantity of material is considered. The beds

used in these experiments, 3 feet wide and 42 feet long, should contain from 16,000 to 24,000 seedlings. The extent of the weeding, it will be readily seen, is in inverse ratio to the perfection of the stand obtained.

It sometimes happens with this kind of seeding that culture, erosion, and weeding over portions of the bed interfere enough with the soil covering to expose some of the bulblets. This should be watched for, and where there is danger of exposure a few shovelfuls of earth should be scattered over the beds to give the necessary protection. Where these agencies have not operated to remove the soil the young bulblets actually work their way deeper. They have a special means to accomplish this in the large, succulent, contractile roots which pull them down into the soil so that normally there is no danger of exposure. In practice, however, under field conditions it is found that a little watchfulness on this point is necessary.

The plants can be expected to be at maturity the third year, although some flowers may be seen the second season under the best cultural conditions. Well-grown seedlings can be marketed at the end of the second year of growth from the seed beds, but usually another season's culture is necessary.

PRIME DIFFICULTY WITH GRAPE HYACINTHS

So prone is this group to disease that it is common to get bulbs in imperfect health from Europe. The storage rots of the plants are not confined to this genus but are reported to pass readily to the closely related garden hyacinth. On account of this danger the European grower of hyacinths, it is said, will seldom attempt the production of grape hyacinths. The cause of the disease is a Sclerotium, commonly considered to be a Botrytis, forms of which cause fire in tulips and damping-off in seedlings of many plants.

In its most prevalent form this disease is easily recognized as a web of white mycelium which mats the bulbs together on poorly aerated shelves or in the pack and finally causes the formation of sclerotia smaller than a seed of mustard. These are white at first, but pass through various stages of brown to black when mature. In the soil the same white mycelium and occasionally the sclerotia may be found. The disease spreads from a focus of infection and usually takes most of the plants as it advances. Soil once infected should be planted to other than bulb crops for two or three years. It is a peculiar fact that plants which persist in such an infected area after two or three years of neglect may exhibit no trace of the diseased condition.

There is no known approved remedy for treating this disease, but preventive measures are efficacious. Care in drying the bulbs so that no sign of mold occurs and growing a new generation from seed whenever the stocks become infected or there is doubt about them are the precautionary methods indicated.

The difficulty of detecting the disease is also a serious matter for the grower, because well-grown stocks of these species if poorly handled seem to develop it. It is claimed that less trouble is found with the health of these bulbs when they are handled on a permanent-

planting basis wherein the propagating stocks are not stored, provided, of course, the initial planting is clean. Just how long this may be practiced can not be stated, but it is reported that with some foreign growers the method is successful indefinitely.

Another malady affecting several members of this genus is one of the true smuts. So far it has proved to be inconspicuous and to have very little effect on the general vigor of the plants. The parasite seems to be perennial in the tissues of the host, but is not outwardly observable except at the time the plant is in blossom. Although not conspicuous, it destroys the value of the cut flowers if the infection is severe, because the florets shed a powdery mass of brown olivaceous smut spores instead of pollen. The fungus fructifies in the ovaries and anthers of the host. It seems to be confined to certain individual plants and not to spread rapidly.

The way to rid a planting of this smut, like the general method of toning up and keeping other bulb stocks up to the required vigor and standard, consists in gouging out and destroying the diseased individuals. The only time to do this is while the plants are in blossom, when the planting should be examined carefully for any sign of the disease. With a little practice this can be done very rapidly if the planting is in beds. A short piece of lath can be used to bend over the flower spikes in a row, so the partially upturned florets can be detected readily. Commonly, every floret of the spike is smutted when the plant is at all infected. All smutted plants should be destroyed by either burning or burying them 2 or 3 feet deep where no bulbs of any kind are likely to be planted.

The cause of this smut is a fungus known to botanists as *Ustilago vaillantii* Tul. It has rarely been reported in this country, but on account of its inconspicuous nature it may very easily have been overlooked. It would be surprising if it has not been imported much more frequently than the records indicate. There is no easy way of detecting it in dormant bulbs. In these experiments it has appeared in the Conicum and Heavenly Blue varieties, but is recorded on others in Europe.

WHERE GRAPE HYACINTHS MAY BE GROWN

The Puget Sound region seems better adapted in some ways to the production of grape-hyacinth stocks than the Atlantic Coastal Plain. The floral display in the Pacific Northwest will always be more satisfactory, because the flowers are slightly larger and the stems longer. The average in the Conicum variety is about a 12-inch pulled stem under open field conditions on Puget Sound. In the vicinity of Washington, D. C., under open field conditions the stems are somewhat shorter. Experience is more limited here, but the few tests thus far made indicate perfectly satisfactory yields of bulbs.

The commoner varieties naturalize and persist indefinitely in New York, Illinois, Mississippi, Alabama, Tennessee, and other States; indeed, in portions of Virginia and Michigan they are conspicuous weeds in cultivated fields. It is believed that the varieties can be successfully produced commercially on any good well-drained sandy loam soil of these regions.

PRESENT DEMAND

As stated, these stocks, although very attractive ornamentals and flowering in the early spring, have not been used in very large quantities in this country. The number used in pre-war days is difficult to determine, but consultations with some of the leading importers supply the basis for an estimate of about half a million bulbs a year, all employed in outside decorative plantings. In 1923, after the country had been deprived of them since 1917, the total importation for the same purpose was a little less than 550,000 bulbs.

It is as a "filler" that the group has been employed in the trade in the past. It has formed one of the miscellaneous items which went to make up the autumn bulb lists. Without any special effort and with an abundance of other bulbous stocks available, half a million or more bulbs were imported and sold.

GROWING UNDER GLASS

In the handling in the greenhouse of the leading varieties, such as Heavenly Blue, Azurea, and Conicum, the best plan is to leave the pots and flats out of doors as long as the weather is good. Potting should be done early, and while it may be advantageous to plunge the pots they should not be covered, as is advised for hyacinths, because top growth starts about as quickly as root growth. No injury except to the pots will result from some freezing, but severe freezes should be avoided, because the leaves will be somewhat discolored or actually killed at the tips.

After being brought inside, a low temperature is advisable. A temperature suitable for carnations is satisfactory, and as much light as possible should be provided. When grown in this way and brought into flower after the middle of January, they make attractive pots. The best varieties for this purpose are Heavenly Blue, Conicum, and Azurea, but all of them may be brought in slowly under glass.

The plants may be carried without heat until January, then in a cool house flowered for Easter, or they may be given a little warmth and flowered in January.

That the use of grape hyacinths for cut flowers is feasible and that the stocks will take on the flower market have become very evident recently. This fact was very satisfactorily demonstrated at Portland, Oreg., by a local florist the past season. He forced and placed upon the market 600 spikes of *Muscari conicum* from 500 bulbs. Before the cut was complete other growers were looking for sources of supply of 10,000 bulbs each. It is believed that this experience will be duplicated on many other markets when the flowers are offered for sale.

On account of its robust habit it is believed that *Muscari conicum* is the best variety for the market. While experience with it in this country has shown flowering in the last half of January, it should be noted that the plant comes into blossom regularly in the field at Bandon, Oreg., by the first of January. It is possible that stocks grown in this region and south of it could be brought in for New

Year's Day. At Bellingham, Wash., it does not blossom out of doors until the middle of April.

YIELDS

Yields of these bulbs under field conditions have been obtained on but two varieties, *Muscari conicum* and *M. comosum plumosum*. The records on both are believed to be reliable and to indicate what is to be expected under the best conditions of fertility and culture in the Puget Sound region.

The stocks used in these experiments were imported in 1917, grown at Bellingham, Wash., for two years, dug, and the increase replanted for another two years. The records are those for 1921 and later.

MUSCARI COMOSUM PLUMOSUM

The records on the Plumosum variety are from plantings made in August, 1919, on unfertilized soils which had raised one crop of potatoes after being cleared of forest growth. The planting stock consisted of the small bulbs from the previous planting. They varied from 6 centimeters in circumference downward. These were planted at the rate of 35 to the 3-foot row.

The record shows that during a 2-year period 3,745 bulbs (107 rows) 6 centimeters and under in size gave a turn-off of 2,500 merchantable stock and allowed an increase in the planting of more than 50 per cent in 1921 (183 rows).[3]

The planting in 1921 was 77 rows with 14 bulbs to the row, 60 rows 21 to the row, and 46 rows 35 to the row, while in 1919 there were 107 rows with 35 bulbs to the row.

THE CONICUM VARIETY

The reproduction in the Conicum variety is well-nigh phenomenal under conditions of reasonable fertility. The conditions under which the yields given below were obtained were identical with those in the case of the feathered hyacinth previously described. The character of the reproduction in this variety is very similar to that of Heavenly Blue, but it is still more vigorous.

Out of a planting of 13,500 bulblets (184 rows) set in 1919 and left in two years there were marketed about 8,000 in 1921, with stock enough to furnish a planting of approximately the same area (180 rows) in 1921 and turn off in planting stock about 8,000 besides. This means that when all the increase up to about 5 centimeters in circumference is planted, about three-fourths of it can be marketed at the end of two years, and an increase of one-third to one-half in the area to be planted back is possible.

In 1923, from a planting of 13,500 bulblets 5 centimeters and under in 1921 it was possible to plant 29,400 bulblets (294 rows) and turn off 13,000, nearly as many as planted.

FUTURE OF GRAPE HYACINTHS

The flexibility in their season of flowering, the use being made of them as cut flowers on the Pacific coast, together with their appeal

[3] A good comparison of yields in bulb culture when the bed method of planting is employed is not necessarily on the basis of the number of bulbs planted and harvested but the number of rows of properly sized stocks so set as to contain not the same number of bulbs but a comparable quantity of plant material.

on the flower market, should appreciably increase the demand for grape hyacinths. It is generally admitted that the group has neither been fully appreciated nor utilized, and it is believed that their ease of culture and wide adaptability, together with a dearth of bulbous items, may greatly increase their use as soon as growers take them up on a productive basis.

It is hoped that this short account will assist in directing the attention of growers to this promising source of bulbous supply for the border, the garden, the flower market, edges of woodlands, and forcing benches.

SUMMARY

The best all-round varieties of grape hyacinths are Conicum, Heavenly Blue, and Azurea. They are adapted to intensive culture and can be satisfactorily produced under very diverse conditions.

While the group has been little used as a florist item in this country, there is evidence that the public will appreciate it when it is offered for sale.

Given clean vigorous stocks to start with, there are few difficulties involved in production, but constant care must be exercised with the bulbs in storage. Well-aerated packs are imperative.

The varieties which reproduce vigorously by vegetative means have a weedy tendency, on which account their production on a semi-permanent basis may be advisable.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

December 15, 1924

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